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17 April 1958

MEMORANDUM FOR THE RECORD

SUBJECT: Aerial Photography at Lower Altitudes

1. PROBLEM: To evaluate capability of the U-2 aircraft to descend to an altitude below high cirrus and/or middle deck cloud cover to obtain aerial photography during marginal weather conditions.

2. FACTORS BEARING ON THE PROBLEM:

a. Without modification, existing camera configurations will produce acceptable quality photography, with adequate overlap, at the following minimum altitudes:

<u>Camera</u>	<u>Ground Speed*</u>	<u>Altitude</u>
6" cartographic	240 Kts	35,000 feet
	220 Kts	32,000 feet
24" camera	240 Kts	36,000 feet
	220 Kts	33,000 feet

B camera not considered for reasons indicated below.

*Ground speed dependent upon wind direction and velocity.

b. Since the U-2 system was designed specifically for a high altitude reconnaissance role, there are certain inherent design limitations in the existing camera configurations which will restrict or have an adverse effect upon the quality of photography accomplished at lower altitudes. There are also other factors, not attributable to design, which must be considered:

(1) On letdown from a higher (colder) to a lower (warmer) altitude, extreme amounts of condensation must be anticipated. This will adversely affect quality of photography if camera lenses or port glasses are fogged. In addition, high condensation or humidity increases probability of film jams, transport problems, etc., caused by film emulsion sticking when wet.

(2) As altitude is decreased, photographic scale is increased - larger scale photography is desirable, especially for tactical interpretation of targets such as troop concentrations, convoy movements, etc. However, as altitude is

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decreased, photographic coverage (the area covered by a single photograph or single flight line) is also decreased. For example, at K plus 20, the A-2 system covers an area on the ground 36 nautical miles in width; the same camera at 20,000 feet, covers an area only 7.5 nautical miles wide.

(3) Design limitations, which may be remedied by modification, include:

(a) Fixed interval setting of existing cameras. Since it was assumed that all missions would be flown at maximum altitude and airspeed, no provision was incorporated for changing interval settings of cameras. (Except for the tracker, on which scan rate may be varied.) In order to obtain adequate (50%) forward overlap of photography, the time between exposures must be decreased as the altitude of the aircraft is decreased. An alternative, but less desirable procedure, would be to slow the speed of the aircraft. For example, the A-2 camera set interval is one exposure every 15 seconds. If a mission were flown at 20,000 feet, the proper interval would be one exposure every 9.2 seconds at 225 knots. Provisions for selecting various interval settings could be incorporated into existing A-2 system by modifying the system programmer. Modification would include provisions for inflight changes in interval by the pilot as the interval settings would vary dependent upon flight line altitude and ground speed of the aircraft.

(b) Image Motion Compensation ratio. I.M.C. was designed for a specific altitude and airspeed range to compensate for forward movement of the aircraft during exposure. Redesign and rework of this system would entail considerable effort. Photography could be accomplished without modifying I.M.C. system, however, quality would be degraded. Higher shutter speeds would help, but we are then faced with the problem indicated in the next paragraph.

(c) Hycon has stated that reliability of shutters will decrease at higher speeds and presently recommend use of only the mid range shutter speed with the A-2 camera system. Higher shutter speeds would be required at lower altitudes.

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(d) Existing Project camera systems utilize a pressure differential vacuum system. Camera manufacturers (Hycon) state this system would be ineffectual at altitudes under 17,000 feet. A new or supplementary vacuum system would be required below that altitude.

NOTE: The 6" A-1 camera system is not recommended for tactical photography since the scale produced, even at lower altitudes, would be too small for interpretation of the majority of tactical type targets. The "B" camera would require a more complex and extensive modification than would the A-2 to permit low altitude photography. This is especially true since the Mini-vib (vibration compensating device) has been removed from the "B" system. It is believed that the "B" would be unacceptable due to increased turbulence and consequent vibration which would be expected at lower altitudes.

3. RECOMMENDATIONS:

a. Recommend using a system (i.e., [redacted] etc.) designed for low altitude (tactical) reconnaissance. Several presently assigned "drivers" have been previously checked out in the [redacted]

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b. If the U-2 and existing equipment is to be used for lower altitude reconnaissance, the following modifications would be required:

- (1) A pilot selective intervalometer
- (2) A supplementary or redesigned vacuum system
- (3) A recalibrated Image Motion Compensating ratio, or
- (4) A "beefed up" shutter which would withstand stresses imposed by utilizing higher shutter speeds required at lower altitudes.

c. If a decision is reached to utilize the U-2 for this purpose, recommend mission planning specify approach to target area at, or as close to as practicable, the target run altitude. This procedure will reduce condensation problem.



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